

Title: First-Year Students' Beliefs About Smartness and Their Beliefs About the Relationship Between Smartness and Socioeconomic Status

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### **Abstract**

In undergraduate engineering programs, we know that students who express beliefs about smartness that are normative (such as prioritizing cognitive ability) are more favored for success, and we know that students hailing from lower-socioeconomic backgrounds are less likely to succeed than their peers with higher-socioeconomic backgrounds. However, there is currently a relative lack of research pertaining to the intersection between socioeconomic status and beliefs about smartness. To contribute to this gap, this study addresses the following research question: *What do first-year engineering students believe about smartness, and what do they believe about the relationship between smartness and socioeconomic status?* I collected qualitative data through one-on-one interviews with fourteen first-year engineering students about their beliefs about smartness and the relationship between smartness and socioeconomic status (SES). Through an iterative, qualitative coding process, I analyzed interviews and developed themes based on their responses. I found that students expressed three major beliefs about smartness: that it was defined by achievement, that it was defined by effort, and that it was a local construct. Students expressed the belief that smartness was effort much more commonly when discussing peers they perceived as not smart. This indicates that students believe that smartness is a mixture of achievement and effort, and that the two have varying importance depending on whether students are discussing smartness or a lack of smartness. I also found that most students believed smartness and SES to be linked in some way, but some students believed the two concepts to not be linked at all. All students, however, acknowledged similar advantages of students with high SES. Further investigation is recommended to more thoroughly investigate students' beliefs about the relationship between smartness and SES.

### **Introduction and Background**

Socioeconomic status (SES) refers to the categorization of individuals on account of their social positioning (such as personal or family education and occupation) and economic positioning (such as personal or family income). Within the context of engineering education, SES has increasingly been viewed as an important consideration when discussing diversity and inclusion at ABET-accredited institutions [1] due to the unique experiences and difference in perspective that people with varied SES backgrounds can bring to the engineering field [2].

Lower-SES students are less likely to enroll in engineering programs, achieve at a lower academic level, and are less likely to graduate within six years [1], but differences in educational experience begins much earlier. Children from lower-SES backgrounds are more likely to possess school-related behavior problems [3], are less likely to encounter experiences that develop reading skills [4] and enter high school with average literacy skills five years behind those of higher-SES children [5]. The lower-SES students who do enroll in engineering programs endure less motivation from family as well as lower confidence in math, science, and open-ended problem solving [6]. In addition to influencing academic outcomes, SES is also an important construct to investigate because it intersects with other, more well-studied aspects of diversity, such as race. For example, far more White Americans have an Associate's degree or higher compared to their Black and Hispanic/Latinx peers, and they have a higher average pretax income [7]. By studying SES in college engineering in addition to existing research on race, a more holistic understanding of diversity can be achieved through the consideration of both.

Within the American education system, academic achievement is also affected by the beliefs that students, teachers, and parents hold about what it means to be smart. Researchers have shown that students were more likely to be framed as smart when their parents' expectations matched their

teachers' expectations [8]. Teacher expectations are not value free; cognitive or analytical forms of intelligence are most valued in American educational contexts [9], and students who do not exhibit these values are at a disadvantage for institutional rewards such as admission into gifted programs [10].

Beliefs about smartness are especially important in engineering. Our discipline focuses heavily on technical and analytical measures of education, and students who enter engineering programs often feel a sense of superiority stemming from their association of their program with difficulty and hard work [11]. This association carries with it the potential to discourage students who do not exhibit cognitive or analytical forms of intelligence from entering engineering programs or deny them institutional reward [10], and if lower-SES students value non-normative forms of intelligence, their ability to succeed would be systematically inhibited.

### Research Questions

Currently, lower-SES students achieve academically at a lower level and are less likely to graduate within six years than higher-SES students [1] and students with beliefs aligned with their teachers' beliefs benefit from more institutional reward [8]; however, researchers have not yet focused on what engineering students believe about the relationship between smartness and SES. To contribute to this gap, I aim to answer the following research question: *What do first-year engineering students believe about smartness, and what do they believe about the relationship between smartness and socioeconomic status?*

### Methods

To answer the research questions, I utilized qualitative research techniques. This included conducting 14 one-on-one, semi-structured interviews with first-year engineering students in order to allow them to share their experiences in an open-ended manner while also ensuring that the interview enabled the collection of relevant data for my research question. It's important to note that this data has a sense of validity different from quantitative data; my goal was to fairly represent and communicate the data through the lens of my study's objectives [12]. The students who participated in this study, with relevant demographic information, are listed below in Table 1. The right-most three columns of this table include self-reported data and were most important in my selection process, as I wanted to include participants that would result in a group with high socioeconomic diversity. It should also be noted that the "Occupation" column included some responses that could identify the participant; these were altered slightly to be more generic and are seen in written in brackets in the table.

**Table 1:** Self-reported participant information

Pseudonym	Gender	Race	Estimated Household Income	Legal Guardian(s) Occupation	Highest Education of any Guardian
Abby	Female	Caucasian or White	Above \$225,251	Father is a loan officer, mother holds a couple part-time stay-at-home jobs, doing booking for a couple small companies	Bachelor's Degree
Ben	Male	Caucasian or White	Don't know / prefer not to answer	Both of my parents are nurses.	Bachelor's Degree

Chris	Male	Caucasian or White	Above \$225,251	Consultants	Master's Degree
Dani	Female	South Asian (e.g. Indian, Pakistani, Bangladeshi, Sri Lankan, etc.)	Above \$225,251	IT Manager Software Design Engineer	Master's Degree
Eric	Male	Caucasian or White	Between \$24,003 and \$45,600	[Retail] Employee [Retail] Employee	Some College
Frankie	Female	Other Asian	Don't know / prefer not to answer	Nail Technician IT Worker	Bachelor's Degree
Grace	Female	Caucasian or White	Between \$74,870 and \$121,018	Assistant Store Manager Head of customer service for a small company	Master's Degree
Hannah	Female	Caucasian or White	Between \$121,019 and \$225,251	Mechanical engineering, Teacher	Doctorate Degree
Isaac	Male	Caucasian or White	Between \$74,870 and \$121,018	high school teacher, technology assistant	Master's Degree
Justin	Male	East Asian (e.g. Chinese, Korean, Japanese, etc.)	Between \$45,601 and \$74, 869	Radiologist, warehouse worker	Bachelor's Degree
Kevin	Male	Caucasian or White	Between \$45,601 and \$74, 869	Data Analyst Jeweler	Master's Degree
Laura	Female	South Asian (e.g. Indian, Pakistani, Bangladeshi, Sri Lankan, etc.)	Between \$121,019 and \$225,251	[Operations Analyst]	Master's Degree
Matt	Male	Caucasian or White	Between \$121,019 and \$225,251	Continuous Improvement at [Corporation]	Bachelor's Degree
Natalie	Female	African American or Black	Between \$45,601 and \$74, 869	Unemployed, financial analyst	Bachelor's Degree

In accordance with IRB protocol, I recruited students of at least 18 years of age or older from first-year engineering courses with a short, in-person presentation that educated students about the project, informed them of the incentive to participate (a \$20 Amazon gift card upon interview completion), and provided them with a link to a Qualtrics survey. The survey consisted of standard demographic inquiries (such as gender/ethnicity/race/etc.) followed by questions pertaining to the student's economic status (such as *What is your estimated household income?*) and to their social status (such as *What is the highest completed education level of your parent/guardian?*). The survey ended with an opportunity to provide contact information. Student responses influenced my selection of interview participants, as I aimed for a diverse group – particularly one that represents a wide range of SES. While I originally intended to determine each student's SES using a largely agreed-upon three-point measurement that consists of parental income, parental education, and parental occupation [13, 14, 15] and interview a socioeconomically diverse group of students, survey and interview scheduling responses quickly revealed a group with a largely homogenous income bracket, as only one student with an estimated household income below 40<sup>th</sup> percentile accepted an interview. With one major branch of SES measurement showing a lack of socioeconomic diversity in my sample, I decided to shift the study's focus towards a more general investigation into student beliefs about smartness and SES.

Though low incomes were sparsely reported, I still aimed to include participants with demographic backgrounds as broad as possible. As a result, two students listed in Table 1 were included despite not reporting an estimated income: Ben and Frankie. Both reported parental/guardian occupations that are deemed “pink collar” [19] – a job class including careers historically associated with women that was not well represented by the other participants included.

I contacted students who I wanted to interview via e-mail to determine a mutually acceptable meeting time and date. The interview protocol was constructed to last approximately 30 minutes, and consisted of questions regarding students’ beliefs about smartness (such as *Who do you think is the smartest person in your engineering class and why?*) and their views about how SES affects those beliefs (such as *How do you think SES influences how smart someone is?*). There are multiple definitions of socioeconomic status that are used in research, and I hoped to provide a standardized context in which student could discuss the relationship between smartness and SES. To assist students in the interview, I presented the following definition from the American Psychological Association: “Socioeconomic status is the social standing or class of an individual or group. It is often measured as a combination of education, income, and occupation,” [20].

I recorded each interview and submitted the recording to Rev.com (a professional transcription service) for automated transcription. I then “cleaned” each interview, which entailed correcting any mistakes from the automated service and removing any identifying information from each transcript to protect participant confidentiality – such as specific classes or hometowns – and replace it with generic substitutions in order to protect participants’ identities. For example, if a student says, “I grew up in Mason, Ohio,” the final transcript will read “I grew up in [a Midwest suburb].”

For analysis, I utilized Open and Eclectic coding to identify common themes and group multiple first-round codes into more general statements in an organized manner [18]. I developed a codebook from a small sample of interviews using an iterative coding process in which I identified, with initial assistance from a co-researcher, broad and common themes from initial descriptions and gradually evolve into specific codes. Once I established a codebook, I utilized Dedoose – a qualitative coding and analyzation software – to analyze the remainder of the interviews.

## **Results**

### *Beliefs About Smartness*

When the participants expressed beliefs about smartness, many of their comments could be categorized in one of the following ways: 1) smartness is achievement, 2) smartness is effort, or 3) smartness is a construct. Students who believed smartness is achievement related to their own or other’s smartness to tangible successes such as test scores or GPA, like Matt does in the quote below.

*“I felt really smart last semester. Uh, I got a couple hundreds on the chem exam when the average was like 60.”*

*-Matt*

The importance of achievement in student’s beliefs about smartness can perhaps be seen even more clearly when discussing what makes them feel *not* smart. When asked to provide examples of this feeling, many students quickly recalled a test score they obtained recently in their engineering program. In the case of Eric, below, he expressed the importance of a grade on his smartness even before the grade is actually received. Though he acknowledged that he didn’t “technically” know the outcome of his exam, he still related his feeling of not being smart to his performance on that single exam.

*“Yesterday actually I had a, a chemistry midterm that did not go very well at all. I haven’t got my score back, so I really technically don’t know the outcome, but I just did not feel*

*smart because it did not know near as thought at near as much as I thought I did on the midterm."*

*-Eric*

Students also expressed the belief that smartness was effort, though less commonly than the belief that it was achievement and positioned effort as a means to match the ability of people who were innately more skilled or more intelligent, demonstrated below in a quote from Justin.

*"Like even though like somebody might not be as like naturally gifted as something, like, like you can, like, somebody can make up the difference by like, just putting in like a lot more work to like developing those skills versus like somebody who's like naturally gifted it and they like, don't do anything."*

*-Justin*

The most interesting aspect of students' belief that smartness is effort, however, is that it almost exclusively arose when discussing the concept of *not* smart as opposed to smart. They spoke of peers in their classes, project team members, and hypothetical generalizations as being not smart specifically when they did not put forth effort. In every case, the effort described was one dimensional – equated simply with time put into an assignment or class – as shown below in a quote from Hannah.

*"I don't like to say at least smart, but I guess they did not turn in assignments just regularly and allow their grade to drop every single assignment. Didn't study for the midterms, didn't try to learn the coding."*

*-Hannah*

Most often, students expressed beliefs that smartness was either achievement or effort, but some students – whether purposefully or inadvertently – expressed the belief that smartness is socially or locally constructed. Students who expressed this belief acknowledged that smartness is a factor of the surrounding environment or circumstance. This acknowledgment varied between comments about how someone's history can affect their standing, how engineering education is dependent on quantifying performance, and how people can be perceived as not smart because of the expectations of an assignment. In a quote from Natalie, below, she expresses the latter. These beliefs align with extant literature finding that smartness is locally constructed and dependent on the beliefs of the educator [21].

*"If they still failed, I would say they just...didn't think about it in the way that they had to think like- Say for example, if you're given a problem and like they want you to think, usually they want you to think about doing it in the most efficient way or the fastest way. And you're not smart if you're not thinking about it the same way that they want you to think about it. Or if you're not asking someone else to think of like your professor or TA or whatever, to help you think about it in the way they want you to think about it. I think that's not being smart."*

*-Natalie*

The discussion of smartness as achievement and as effort when combined with the patterns of their occurrence – achievement was discussed consistently whereas effort was discussed more frequently in relation to not smart – raises interesting points regarding their relationship. From these responses, students likely believe smartness to be a mixture of the two beliefs, and the relevance of

achievement verses effort likely scales along a spectrum from not smart to smart. A summary of students' beliefs about smartness along with their definition and frequency is shown below in Table 2.

**Table 2:** Summary of students' beliefs about smartness including codes, definition, and frequency.

Code	Definition	Frequency
Smartness Is Achievement	Students define their own or others' smartness based on tangible successes, achievements, or validations.	Almost all students
Smartness Is Effort	Students define their own or others' smartness based on the time or work put into a class or assignment.	Almost all students (specific to talking about <i>not</i> smart peers)
Smartness Is a Construct	Students acknowledge that smartness is contextual and a factor of the surrounding environment and/or circumstance.	Majority of students

#### *Beliefs About the Relationship Between Socioeconomic Status and Smartness*

When asked about the relationship between SES and smartness, student responses could be assigned as expressing the belief that the two were either linked or unlinked. Most responses expressed a belief that the two concepts were linked in some way. The strength of the link varied some between participants, but most, such as Chris and Abby in quotes below, acknowledged that people of a high SES benefitted from their access to more resources, as they were able to spend less energy on necessities like food and clothing.

*"I think for the most part people- there's probably a pretty good correlation between socioeconomic class and like how well you perform. Cause like I said, you have more time to just focus on studying or achieving things, whatever those are or is in the other like if you're lower on the socioeconomic class you have to, you know, take care of the basic functions first, which would severely limit how you study."*

*-Chris*

*"When I look around at who I consider smart, um, it was someone who like, didn't have to worry mentally about like- they didn't have to worry. So like they didn't have to worry about like where their clothes were coming from, where their food was coming from or if the heat would be on. Um, it was someone who could just sit down and like focus on their studies."*

*-Abby*

Some students rejected the notion that SES and smartness are linked at all and are immune from influence from one another. Those who expressed this, interestingly, gave very similar responses to those who said SES and smartness were linked with each other. They, too, acknowledged that people of a high SES have access to better resources and can therefore succeed at higher levels. The students who rejected the notion that the two concepts were linked did so in one of two ways: by expressing their belief that smartness was either innate or constructed, shown below in quotes from Frankie and Hannah, respectively.

*"I think like there's no like connection between how smart you are and how like socioeconomic status like wouldn't play into it. So it's more an inherent quality."*  
-Frankie

*"I don't think there's a link. I think that smartness as we perceive it is partially based on education level, which is completely independent areas is dependent on socioeconomic status. But like true intelligence, I think that anyone can be really smart. It's just the access to tools, education that define their smartness as per society."*  
-Hannah

Most students expressed beliefs that smartness was both achievement and effort, but there was no trend regarding students' beliefs about smartness and their beliefs about the relationship between smartness and SES. Students who believed that smartness and SES are linked expressed at some point both a belief that smartness was achievement and was effort. All students who believed that smartness and SES are not linked expressed the belief that smartness was achievement, and half also expressed the belief that it was effort. Though this may point to a meaningful discrepancy regarding students' beliefs about smartness and their beliefs about the relationship between smartness and SES, it should be noted that far fewer students expressed the belief that smartness and SES were not linked than the belief that they were. A summary of students' beliefs about the relationship between smartness and SES, along with their definition and frequency is shown below in Table 3.

**Table 3:** Summary of students' beliefs about the relationship between smartness and SES including codes, definition, and frequency.

Code	Definition	Frequency
Smartness and SES are Linked	Students believe that the two can influence each other to some degree.	Almost all students
Smartness and SES are not Linked	Students believe that the two are separate entities that are immune to influence from each other.	Minority of students

This data opens up multiple routes for further investigation. These include potential future studies regarding the differentiation in whether students believe smartness is innate or malleable, the expansion of students' beliefs about smartness as a construct, and student beliefs about socioeconomic status itself. Most importantly, further investigation is warranted into whether students believe smartness and SES are or are not linked and into the nuances of any potential link students describe. A larger sample size with more focused and detailed questions about the relationship between the two would assist in uncovering relevant information about students' beliefs about smartness, and the relationship between the smartness and SES.

## **Conclusions**

This study utilized semi-structured one-on-one interviews with fourteen first-year engineering students to investigate their beliefs about smartness and beliefs about the relationship between smartness and socioeconomic status. Participants were selected with a goal of broad representation of students from different demographic backgrounds. Through an iterative coding process, I found that students commonly expressed the beliefs that smartness was achievement, was effort, and was a local construction. I also found that most students believed smartness and socioeconomic status were linked

in some way, but some believed the two were not linked at all. An implication of my findings is the possibility that students believe smartness is defined by achievement, whereas a lack of smartness is defined by effort. The major limitation of this study was its lack of inclusion of low-income students – only one with an estimated income below 40<sup>th</sup> percentile was included. Future work should include more in-depth investigation into students' beliefs about the relationship between smartness and socioeconomic status and the inclusion of a more economically diverse participant pool.



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